Dr Yohann Duguet

Post-doctoral researcher in Fluid Dynamics

21, Tomtebogatan, SE-11339 Stockholm, Sweden
Born on 21^{st} April 1977
French Nationality, Male
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2008-2009 **Post-doctoral researcher at KTH Mechanics**
Post-doctoral position at KTH Mechanics, Linné Flow Centre, Stockholm, Sweden
Numerical study of transition to turbulence in wall-bounded shear flows
Supervisor : D. Henningson

2006-2007 Marie Curie Fellowship at the School of Mathematics, Bristol, UK
Numerical Investigation of Periodic Orbits of the Navier-Stokes Equations in cylindrical Pipe Flow
Supervisor : R.R. Kerswell

2003-2005 **Research and Education Assistant**
U.F.R. Mécanique- Université Claude Bernard Lyon 1, France

2000-2004 **PhD in Fluid Dynamics**
Numerical Simulation of the Hydrodynamic Instability in a Rotating Gas Cylinder subject to Sinusoidal Compression, LMFA (Laboratory of Fluid Mechanics and Acoustics), Ecole Centrale de Lyon, France.
PhD Supervisor: Pr. J.F. Scott, co-supervisor: Dr. L. Le Penven

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1998-1999 **Diplôme d'Etudes Approfondies (D.E.A.)**
Numerical Analysis, Partial Differential Equations and Applied Mathematics, Ecole Centrale de Lyon, Université Claude Bernard Lyon 1 and Ecole Normale Supérieure de Lyon, France.

1996-1999 **Engineer Degree**
Ecole Centrale de Lyon, France *specialisation : Mathematical Modelisation in Fluid Dynamics.*

1996-1997 **Bachelor of Pure Mathematics**, Université Lyon 1, France.

Research Activity

My current post-doctoral research at KTH deals with various ways to turbulence in plane shear flows (plane Couette, plane Poiseuille flow). The emphasis is on nonlinear optimal perturbations, as well as application on dynamical systems theory to spatially extended systems, untackled at the moment. My research at Bristol University was the first attempt ever to apply new tools from dynamical systems theory (Periodic Orbit Theory) to the problem of transition to turbulence in an incompressible circular pipe flow. I have developed cutting-edge numerical methods to find exact (unstable) periodic solutions of the 3D Navier-Stokes equations. I have developed a numerical procedure to identify which Travelling Wave solutions are most visited during the process of transition from a laminar to a turbulent flow, as well as evidence for heteroclinic connections between them. I have shown the first evidence for such unstable periodic solutions bifurcating from the traveling waves solutions recently found by Wedin & Kerswell (2004). I have also developed tools for the investigation of the Lagrangian mixing properties of passive tracers in such exact recurrent flows.

During my PhD, my research activity has mainly focused on the various instabilities in rotating flows, and their numerical simulation. The main motivation is the study of inertial wave interaction in rotating flows, especially when these waves are subject to an external oscillatory forcing and the flow undergoes instability. I have written an axisymmetric Direct Numerical Simulation Code (DNS) from scratch in order to simulate the flow of gas inside a confined cylinder subject to axial harmonic strain. The development of this code demanded a new original spectral algorithm to take into account the deformable domain, the thin viscous layers and the velocity singularities in the corners. This has firstly led to an accurate description of the marginal stability region in the parameter space. Secondly this allowed us to characterize the basic state, and both the linear and non linear phases of the instability mechanisms as a parametric resonance involving inertial modes of the flow.
After my PhD I investigated the existence and stability of axisymmetric oscillatory jets/shear layers emanating from singular geometrical singularities inside a rotating cylinder. I showed numerically the possibility for triadic coupling of inertial modes, yielding an aperiodic flow which is a precursor for transition to chaos (inertial wave turbulence) in rotating flows.

Major Achievements and Results

- Numerical evidence for existence of spatially localised steady states in plane Couette flow
- Development of Newton-Krylov solvers for periodic orbits
- Development of a numerical procedure to identify Travelling Wave solutions located on the laminar-turbulent boundary in pipe flow
- Discovery of heteroclinic/homoclinic connections in state-space of pipe flow
- Discovery of periodic orbits bifurcating from Travelling Wave solutions in pipe flow
- Development of a 3D DNS code for pipe flow using spectral/finite-difference methods
- Study of Lagrangian mixing in exact coherent structures in pipe flow

- Analysis of a new parametric instability in rotating flows
- Writing of the DNS code from scratch using non-classical methods
- Analysis of the instability of oscillatory jets/shear layers in rotating flows
- Evidence for Inertial wave triadic instability

- Scenario for transition to turbulence in inertial wave turbulence

Involvement in other Research Groups

april-july 1999 Internship at ONERA Chatillon (France) supervised by Pierre Sagaut, *"Development of a Discontinuous Galerkin Finite-Element method for the Direct Numerical Simulation of Compressible Flows".*

june-july 1998 Internship at CSTB Grenoble (France) supervised by Yannick Gabillet, *"Experimental Study of Noise Propagation through a Forest".*

Publications

Transition in pipe flow, the saddle structure on the boundary of turbulence,
Y. Duguet, A.P. Willis, R.R. Kerswell, Journal of Fluid Mechanics, **613**, pp. 255-274 (2008).

Relative periodic orbits in transitional pipe flow,
Y. Duguet, C. Pringle, R.R. Kerswell, Physics of Fluids, *in press*, *November 2008.*

Highly-symmetric travelling wave in pipe flow,
C. Pringle, Y. Duguet, R.R. Kerswell, Philosophical Transaction of the Royal Society, in press.

Slugs, localised structures and the laminar-turbulent boundary in pipe flow,
A.P. Willis, Y. Duguet, R.R. Kerswell, in preparation.

Oscillatory jets and instabilities in a rotating cylinder,
Y. Duguet, J. F. Scott, L. Le Penven, Physics of Fluids 18, 104104 (2006).

Instability inside a rotating gas cylinder subject to axial periodic strain,
Y. Duguet, J. F. Scott, L. Le Penven, Physics of Fluids 17, 114103 (2005).

Conferences

October 2008 *Ercoftac SIG 33 Workshop on Transition and Control, Santa Marharita, Ligure, Italy, "Edge states and puff-like turbulent regimes".*

September 2008 7^{th} *European Fluid Mechanics Conference (EUROMECH), Manchester, UK, "Lower-branch solutions and the transition to turbulence in pipe flow".*

June 2008 *Second France-Canada Conference, Montreal, Canada, "Lower-branch solutions and the transition to turbulence in pipe flow".*

September 2008 *Workshop on the Nature of High Reynolds number turbulence, Isaac Newton Institute, Cambridge, UK,*
"The role of finite amplitude solutions in transitional pipe flow".

june 2007 *SIAM Conference on Applications of Dynamical Systems, Snowbird, Utah, USA, "Exact Recurrent Patterns in Cylindrical Pipe Flow" .*

september 2006 *Kyoto-Birmingham University International Symposium on Recent Advances in Fluid Mechanics, University of Birmingham, UK.*

july 2006 6^{th} *European Fluid Mechanics Conference (EUROMECH), Stockholm, Sweden, "Oscillatory jets and triadic instability in a closed rotating Flow" ,*

Book of Abstracts of the 6^{th} *EFMC 2006.*

september 2005 *Congrès Francais de Mécanique, Troyes, France,*
"Résonance paramétrique dans un écoulement tournant périodiquement compressé" ,
Actes du$XVII^{eme}$ *Congrès Français de Mécanique, 2005.*

july 2004 10^{th} *European Turbulence Conference, Trondheim, Norway,*
"Instability of a confined rotating flow subject to periodic strain" .

september 2003 *Congrès Français de Mécanique, Nice, France,*
"Simulation numérique des instabilités hydrodynamiques
dans un cylindre de gaz soumis à une compression périodique",
Actes duXVI^{eme} *Congrès Français de Mécanique, 2003.*

august 2003 5^{th} *European Fluid Mechanics Conference (EUROMECH), Toulouse, France,*
"Numerical simulation of the instabilities
in a rotating gas cylinder subject to periodic compression" ,
Book of Abstracts of the 5^{th} *EFMC 2003.*

july 2003 6^{th} *International Conference on Theoretical and Numerical methods for Wave Propagation, Jyväskylä, Finland, "Destabilization of Inertial Waves in a Rotating Cylinder", Cohen-Heikkola-Joly-Neittaanmäki editors,* Springer Verlag.

Seminars

2008 *Linné Flow Centre, Kungliga Tekniska Högskolan, Stockholm, Sweden*

2008 *Insitut Jean Le Rond d'Alembert, University Paris 6, Paris, France*

2007 *LIMSI, University Paris-11, Orsay, France*

2007 *LMFA, Ecole Centrale de Lyon, Ecully, France*

2007 *Departament de Física Aplicada, Universitat Politècnica de Catalunya, Barcelona, Spain*

2006 *School of Mathematics, University of Bristol, United Kingdom*

2005 *Laboratoire de Géophysique Interne et de Tectonophysique, (Equipe de Géodynamo), Université Joseph Fourier, Grenoble, France.*

2005 *Technische Universitaet Ilmenau, (Forschergruppe Magnetofluiddynamik), Ilmenau, Germany.*

2004 *Laboratoire de Modélisation et Simulation Numérique en Mécanique et Génie des Procédés (L3M), Université de Marseille-Aix-en-Provence, France.*

Teaching

2006-2007	*Multivariable Calculus and Mechanics tutorials, University of Bristol*
2002-2004	*Fluid dynamics for earth scientists, Ecole Normale Superieure de Lyon*
2002-2004	*Introduction to fluid dynamics, University Lyon 1*
2002-2003	*Experimental methods in acoustics, ISTIL-Lyon 1*
2000-2002	*Ocean and atmosphere dynamics, Ecole Centrale de Lyon*
2000-2001	*River and coastal flow dynamics, Ecole Centrale de Lyon*
1999-2001	*Introduction to viscous flow theory, Ecole Centrale de Lyon.*
1999-2004	*Experimental study of cylindrical and diverging pipe flow, Ecole Centrale de Lyon and University Lyon 1*

Languages

French	*mother tongue*
English, German	*fluent*
Swedish, Spanish, Italian	*written and spoken*

Computer skills

Programmation	*Fortran 90/95, C++, parallel computing.*
Environnements	*Linux, Windows.*
Scientific softwares	*Maple, Matlab, Gnuplot.*